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(54) Title: SYSTEM FOR THE COLLECTION AND DISTRIBUTION OF TRAFFIC AND PARKING FEES

(57) Abstract

A cellular system for mobile telecommunication divided into location areas and comprising Mobile Units (MUs) installed in vehicles, whose identities are registered in this system together with the identity of the respectively installed MU, and that data about status and location area for respectively MU is being reported to the system when these data change whereby the vehicle status in different location areas and its movement between such location areas is registered in the system. The location areas are further divided into cells in which information is broadcast to the MUs regarding traffic and parking fees in the cell for different vehicle classes, and who is entitled to these fees, and that the MUs also contain data about the vehicle class for the vehicle and that these data together with the vehicle traffic or parking time within respectively cell is a part of the MUs own determination of the resulting traffic or parking fee which is reported to the system when the vehicle parks or starts.

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TITLE

System for the Collection and Distribution of Traffic and Parking Fees

FIELD OF THE INVENTION

The present invention relates to a system for the collection and distribution of time and space based traffic and parking fees according to the introduction in claim 1.

BACKGROUND OF THE INVENTION

New roads at enormous costs are required in many areas to improve the traffic ability and to decrease local environmental loading. To finance such investments also new road and city tolls are planned in these areas. The basic thought is that those vehicles using and wearing the roads should also pay for the roads and their maintenance. Further it is believed that tolls also will affect the traffic flow and improve the traffic ability.

The implementation of such toll stations will in first place cover certain highways and road entries to certain cities. A more general implementation is limited by the very high costs for such installations. However the consequence might be that the traffic flow prefer free roads, increasing the wearing and decreasing the traffic ability and security on these roads. The traffic into the cities might be decreased but inside these areas there are no economical incentives to limit the traffic.

What is naturally preferred is a fair cost sharing that in the same time will spread the traffic flow in time and space. However this will also require time and space based traffic fees in major city areas.

The mobile telephone system GSM has had a tremendous development and today it is really a global system. Prices on GSM phones have also dropped heavily and manufacturing costs will continue to drop. Shortly speaking GSM now represent an existing international infrastructure that can be used by anybody for a very slight investment. What makes GSM of special interest for traffic fees is that it is a mobile system, with close to full European coverage, that knows when its mobile units (MU) are set on and in what location area. The MUs them self also knows in which subpart of the location area they are located. Within a synonymous approach where the mobile system is converted to a road system and the MUs into vehicles, these GSM features could also be transferred to a new system for traffic fees.

The use of the GSM network to positioning a certain vehicle related MU is also described in the International Patent Application WO 9630884. Here it is also pointed out that such a positioning could be made without loading the GSM network. It is however wrongly stated that such a positioning could be made on a cell level. Normally the GSM network is only updated when the MU move to a new location area and such an area could contain more than fifty cells.

The International Patent Application also describes how a vehicle related MU could determine its position from cell identity information and the comparison between signal levels from different cells. The vehicle position and status could then be communicated to a central computer using the GSM network. The European Patent Application EP 0501058 also describe in a similar way how a vehicle related MU using cell identity information could communicate its position to a central computer.

No one of these patent applications shows how GSM or any other cellular system could be used for the collection and distribution of traffic fees.

Since the parking systems is such an important part of the total traffic system then parking fees most likely is a part of the same traffic policy controlling the traffic fees. Traffic and parking fee transactions also involves the same parties, that is vehicle owners and regional and local authorities, why it would be most preferable if one system could include both traffic and parking fees.

The International Patent Applications WO 9627170, WO 9611453 and WO 9320539, all describes how parking fees could be debited by the use of some mobile telephone network. For instance from the vehicle the GSM network could be used for communicating at what time the parking starts and stops together with the user and vehicle identity information.

In these patent applications it is of less importance which type of telephone network being used and consequently they do not either take use of the specific GSM network information about the MU status or position.

Consequently there is a need for a general system for a common and efficient collection and distribution of time and space based traffic and parking fees using the GSM networks as an existing infrastructure with a large geographic coverage.

SUMMARY OF THE INVENTION

The object mentioned will be obtained by a system according to the present Invention, which characteristics is made clear by the subsequent claim 1.

A system, covering both traffic and parking fees, may take use of the existing GSM network with inexpensive MUs, mounted in vehicles, whose operating status are registered in time and space without loading the network with traffic. Debiting can also be made through the GSM network using time and space dependent tariffs, such as fee per minute, that is communicated to the MU. These tariffs can also depend on the vehicle classification, allowing the

vehicle weight and environmental rating to affect the fees. Surveillance and control can be arranged very efficiently without disturbing the individuals need for anonymity.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

In the following the invention shall be described.

The national GSM network is divided into switching areas which each can be subdivided into location areas. Within a location area the MU may move around without updating the Visitor Location Register (VLR). The location area includes one or several base stations each covering a number of cells.

During transportation the MU continuously watches the broadcast control channel, from which it will identify its present location area and cell. First when the MU moves into a new location area it will update the VLR.

Each MU belongs to a Home Location Register (HLR). This register contains all necessary subscriber and MU information, such as present status and VLR with location area. If the MU moves to another location area belonging to another VLR, then all relevant registered parameters for the MU will be transferred from the HLR to this new VLR. In the HLR the address will now refer to this new VLR.

Consider a system for traffic fees in which the regional or national road areas are geographically adapted to the GSM location areas. Then assume that all vehicles within these areas are equipped with a fixed installed GSM MU, that switched on and off when the vehicle start and park. The MU also contains a SIM (Subscriber Identity Module) that beside normal subscriber and network information also contain vehicle information such as owner, registration number and classification.

Since the single MU never will be called directly in the system then it don't need to be registered in the HLR, and for such MUs the VLR will never initiate HLR. Instead the current VLR communicates status and location area for the MU to a new Traffic Fee Register (TFR). This TFR is a central, regional or national, database that also contain vehicle data from the SIM registered together with the MU identity and network operator.

TFR now has information about the MUs presence in different location areas, and if the tariffs are fixed in each location area this information is sufficient to calculate the traffic fee. However since the location areas are large it might be preferred to vary the tariffs inside these areas. Besides this the fees should eventually be distributed to different tariff owners within the location area. Such a variation and distribution of tariffs may take place on a cell level with the MU actively involved.

Inside a cell special information can be broadcast as a general SMS (Short Message Service) on a certain channel. The method is called cell-broadcast and can be used for common messages to all those MUs inside the cell that has been instructed to listen to the channel.

This method could then be used by TFR to broadcast, inside each cell, information regarding tariffs and tariff owners to the MUs in the vehicles. From this information the MU then can calculate on its own the corresponding traffic fee in all visited cells during the trip. After the trip and before the MU is disconnected from the network it can send a SMS to the TFR to declare the accumulated traffic fee to each tariff owner within the visited location areas. Also the time spent in these location areas can be declared. The TFR address may be broadcast along with the cell tariffs.

From the TFR information, about time spent by the MU in different location areas, the declaration can be judged and approved before the traffic fee is debited the MUs and credited the tariff owners traffic accounts. After this all

location data for the MU will be removed from the TFR. If the TFR do not receive any declaration it might debit the MU according to a standard procedure using the highest cell tariff in each visited location area.

If the cell-broadcast information also contain tariffs and tariff owners for general parking inside the cell, and if the MU can be switched on manually when the vehicle has been parked, then this system may also be used for parking fees. The register will then be a central Traffic and Parking Fee Register (TPFR).

When the vehicle starts after the parking the MU can send a SMS to TPFR and declare the parking fee, which is debited the MUs and credited the tariff owners parking accounts. After this the location time for the MU will be reset in the TPFR. If no declaration is received then the TPFR may, as before, debit the MU according to a standard procedure using the highest cell tariff in the current location area.

When a vehicle enters a new location area administered by a new TPFR this will be initiated by the VLR. At the same time the MU will discover this on its own when a new TPFR address is found from the cell-broadcast. The MU then first will send a declaration to the old TPFR, in which it also informs about the transition to a new TPFR. After this the MU sends a SMS to the new TPFR with information about the vehicle, the MU identity and network operator, as well as which TPFR that carries the MU account. This information is stored in the new TPFR until the vehicle transit to another TPFR.

The MU will declare its fees to the new TPFR in a regular way. To debit the MU the new TPFR will transfer the charged fees to the TPFR that carry the MU account. At the same time a general balance account between these two TPFRs is debited. If the system involve several countries then all tariffs and

fees should be specified in a common currency, and within Europe then preferably ECU.

The vehicle installed MU can be made up by a GSM module with SIM and a microprocessor with memory. The SIM contain information about the MU identity, its network and channels for cell-broadcast together with the vehicle classification, used for the tariff selection inside the cell. It also contains information about the vehicle owner and registration number and which TPFR that carry the MU account. The microprocessor select tariffs and calculates traffic and parking fees, after time spent in each cell, which accumulates to different memory registers. The microprocessor also handles the SMS from the MU.

The user interface consists of a display and a push button. The MU is connected to the vehicle battery and ignition, and when the vehicle starts the MU will switch on and connect to the network whereas the VLR will initiate the TPFR. When the vehicle ignition is turned off the MU will send a SMS to the TPFR, declaring calculated traffic fees and time spent in current location areas, and then disconnects from the network. If the ignition is turned off the MU can be switched on manually, using the push button, for parking. Afterwards when the vehicle restart the MU will send a SMS to the TPFR regarding calculated parking fee and time spent in the location area.

If the MU and the ignition is on the cell traffic tariff is displayed. If only the MU is on the cell-parking tariff is displayed. Accumulated traffic and parking fee, totally and since last reset, may be temporarily displayed after pushing the button. To reset accumulated values the button is pressed a certain time when the value is shown. However totally accumulated values can not be reset.

The system automatically control that fair fees are debited each vehicle in which the MU is switched on. To secure that the MUs really are on, another type of surveillance must be used. However to check a single vehicle is very easy. Using the vehicle registration number one can directly ask the TPFR if the vehicle is shown to be in the current location area. In this way one can confirm that the MU is switched on and that the vehicle carries along the MU.

Using image processing a computer-based camera may read the vehicle registration number and through, data communication with TPFR, confirm that the MU inside the vehicle is switched on. In this way the traffic may be automatically checked by fixed camera systems at road entries to the traffic area. Inside the traffic area mobile hand held control systems may be used by traffic wardens etc.

The individuals anonymity is protected firstly by that TPFR never show externally the vehicle location during the trip, and secondly by that no location data is stored in TPFR after the trip. Above this it is also unimportant to register the driver since it is the owner who is responsible for paying the fees, as with traditional parking fees.

Vehicles that are normally not included in the system may simply be registered as visitors by a common pay-call. In a voice answering system, connected to TPFR for the area, the visitor may select traffic region and state the registration number on the day for the visit. The visitor is now registered in TPFR in case of an eventual check. Naturally also some specific through route could be left free, for visitors passing the traffic area, simply by avoid checking this route.

The registration fee is put on the telephone bill for the telephone used for the pay-call. The fee must probably be big enough to prevent the daily traffic from prefer being visitors. The cost of a pay-call does normally not vary over time, but in this case a special service can be developed. Then it also might

be possible to register for a visit during some specific hours of the day. To allow different pricing between normal and heavy vehicles two different pay-call numbers could be used.

The regional map is the natural starting point for adaptation and control of the GSM cell tariffs. The simplest way is to divide the map into different zones, in which the zone tariffs are broadcast in the corresponding cells. Another way is to start from all important traffic points on the map. Actual or expected traffic densities at these points could then affect the tariffs, which could move between a floor and a ceiling. In this way a three dimensional map is received, in which the tariffs creates "mountains" at the traffic points with heights that may affect the route selection. This picture then also need to be communicated to the road users, for instance through Internet which future on will be available in most environment.

When a tariff picture is transformed to GSM cells, the mountains are transformed to platforms determined by the corresponding cell areas. The shape will also vary between different GSM networks due to their different cell structure. In the same time the GSM cells are rather small in heavy traffic areas which simplify the adaptation. Within a bigger city region there can be several hundreds of GSM cells with dimensions from a few hundred meters up to some kilometres. In the countryside single cells could have dimensions of more than ten kilometres. The tariff control lend itself to be managed by a regional traffic centre, connected on-line to the TPFR which forwards the corresponding tariffs through Cell Broadcast within the different GSM networks.

A cell could only have two tariff owners for the same vehicle class, one for traffic fees and one for parking fees. This might result in some problems for boarder areas between communities or regions. However normally both traffic and tariffs are minor in such areas and for big city regions with communities grown together the cells are normally very small.

The traffic fee is progressive in the sense that it will increase per distance in areas with poor traffic ability. This is naturally due to the fee per time unit for running vehicles. Within a tariff area the traffic fee per kilometre will increase with decreasing average speed. This is a fundamental system feature that means a new economical incentive for avoiding to travel where, and when, the traffic ability is poor.

The progressive feature also means that tariff areas normally don't need to be homogenous, and can incorporate parts with both low and high traffic densities. Also transfers between high and low tariff areas will not be that dramatic since the average speed in these areas normally is the same through the transfer part.

In many situations it may be suitable to limit the traffic fee. Partly it might be practical to leave a certain start-up time free for re-parking etc. Simplest is then to set the MU for a fixed delay before it will start to search the network. During this delay the VLR and TPFR will not be initiated and no SMS need to be sent from the MU.

To limit the effect of unforeseen traffic stops, for instance caused by traffic accidents, the Cell Broadcast information also may contain limiting cell tariff times. This means that when the vehicle has spent a certain time in a certain cell the tariff will disappear. The traffic fee in that cell is thereby limited. This technique could also be used to separate local traffic from traffic only passing through the cell. With an increased tariff and decreased tariff time we will be closer to a fixed fee for visiting the cell, which will more hurt the traffic passing through.

By suitable tariff control, regarding different vehicle classes and time of the day, several opportunities for improving the traffic environment will appear. Improved traffic ability only as increased speed will increase nitrogen-oxide

emissions, but a more steady traffic flow will in the same time mean less fuel consumption and less overall emissions.

For instance if one like to limit the hydrocarbon emissions in a certain area then the corresponding cell tariffs could be increased for classes of vehicles without catalysts. If one want to go further certain fees could be debited for cold starting vehicles without preheated catalysts. If location data in TPFR isn't removed until the vehicle restart, the system will know for how long it has been parked and could debit the vehicle a certain time dependent starting fee.

During different types of weather one can also vary the tariffs and at serious situations like inversion one could decide to punish all private traffic. During other situations it may be of interest to limit the heavy vehicle traffic etc. Further one can debit very low or no fees for vehicles owned by disabled, simply by special information on the SIM.

Recent car radio receivers normally include RDS functions with a selection switch for listening to all traffic information broadcast within the region. This information will then have priority compared to other program sources. Within a big city region with several different traffic systems there is a great need of information and in the same time most road users are only affected by a smaller part of this information.

Using cell-broadcast one could specifically initiate those vehicle classes in those cells that are judged to be affected by the present information. The MUs could then control the RDS receiver to only relay such traffic information that should be of interest in that specific cell area, for those specific vehicles. Present RDS receivers then also need to have input for the MU to control the traffic selection switch.

Automatic accident reporting from the MU to the TPFR is also possible if the air bag trig signal is connected to the MU. In this case the MU may send a SMS, including information about the current cell, the cell before and time for transfer, and the cell before that and time for that transfer. From this information the TPFR could use its map database to estimate the position for the latest cell entering and how far the vehicle has moved into the current cell. After pointing out the accident area the TPFR could inform the related alarm central for further actions.

The implementation of traffic fees will in all countries be looked upon as taxation. Some regional or national authority should then also administer the fee collection. Preferably the authority that presently administer vehicle taxes in each country. Especially since these traffic fees fully could replace traditional vehicle taxes. TPFR is a central installation but the tariff control may be distributed to regional traffic centres.

The TPFR operator shall book and collect the traffic and parking fees for the vehicles, and book and pay out the net income to each tariff owner. From the corresponding gross income the GSM operator and the TPFR operator will take their shares. Since several GSM operators are involved their shares could be as percentages on the fees debited through their specific GSM network. This information is registered in the TPFR.

Involved GSM operators may only compete with eventual subscriber fees and subventions of the MU to the public. The TPFR operator here sets the requirement on coverage and functionality. By this arrangement the GSM operators will not be connected with the fee collection itself and any probable bad-will this may cause. Instead they will handle the payment mechanism as a credit card operator with no responsibility for the cost of the services.

The GSM operator may only change the physical GSM cells, within the fee areas, in agreement with the TPFR operator. These restrictions are not valid

for the location areas within the TPFR. Further the GSM operator must continuously repeat the VLR information to the TPFR, regarding the active MUs.

The system supplier shall develop and supply the TPFR, with link features to VLRs, GSM networks and regional traffic centres. As an important system part also the application software for the MU shall be developed and supplied. This software could either come along with the MU from the MU supplier or be downloaded during the MU installation in the vehicle. The interface for the system supplier is outside the GSM specification why a more regular IT company could perform the system design.

With respect to the technical and economical requirements on the MU some leading mobile phone supplier should design this unit. The MU operative system also requires a well performed integration of the GSM module with other parts. The distribution of the MUs will also be most efficient using existing mobile phone distribution channels. The MU installation in the vehicle is performed similar to simpler mobile phone installations. The MU must be directly connected to the vehicle battery and to the ignition key. The public could do this at any car repair shop and also in many cases by themselves.

The Invention is not limited to the above mentioned performance but can be varied within the scope of the subsequent claims.

CLAIMS:

1. A cellular system for mobile telecommunication divided into location areas and comprising Mobile Units (MUs), whose identities are registered in the system together with such information about status and location area that is being reported to the system from each MU when changing status or after identifying and preferring a new location area signal when moving into a new location area, and where the location areas consist of cells, whose respectively cell signal is identified and preferred by said MU when starting in or moving into the cell, c h a r a c t e r i s e d i n, that said MUs are each installed in vehicles, whose identities are registered in said system together with the identity of the respectively installed MU, in such a way that the MU shows an on respectively off status after the corresponding vehicle has started respectively parked whereby the vehicle status in different location areas and its movement between such location areas is registered in the system and that within each cell information is broadcast to those MUs who has preferred the respectively cell signal and that this information contain basic data for determination of traffic fees in the cell for different vehicle classes and who is entitled to these fees and that the MU also contain data about the vehicle class for the vehicle and that these data together with the vehicle traffic time within respectively cell is a part of the MUs own determination of the resulting traffic time and traffic fee to each entitled fee owner which are reported to the system when the vehicle parks.

2. A system according to claim 1, c h a r a c t e r i s e d i n, that the information broadcast within each cell also contain basic data for determination of parking fees in the cell for different vehicle classes and who is entitled to these fees and that the MU could be manually turned on when the vehicle has parked and that data about the vehicle class for the vehicle and parking time within the cell is a part of the MUs own determination of the resulting parking fee which is reported to the system when the vehicle starts.

3. A system according to claim 1-2, c h a r a c t e r i s e d i n, that this is of type GSM (Global System for Mobile Communication) and that the MUs identities together with corresponding vehicles identities are registered in a Traffic and Parking Fee Register (TPFR) to which data about status and location area for the registered MUs are transferred from a related and within GSM normally occurring Visitor Location Register (VLR) after each change in these data.

4. A system according to claim 3, c h a r a c t e r i s e d i n, that cell information are being sent to the MUs through Cell Broadcast using a channel whose number is stored on the MU SIM (Subscriber Identity Module) and that this information also contain data about TPFR and fees per time unit such as traffic and parking tariffs for different vehicle classes with related data about tariff owners and maximum tariff time within the cell.

5. A system according to claim 4, c h a r a c t e r i s e d i n, that the MU SIM, besides normal subscriber and network information, also contain data about the vehicle identity and related vehicle class which control the MU selection of traffic or parking tariff within that cell the vehicle use or parks and that corresponding fees are calculated after the time, or tariff time, spent within each such cell and declared as accumulated traffic or parking fee to respectively tariff owner through a SMS (Short Message Service) to the TPFR when the vehicle use or parking stops in this cell.

6. A system according to claim 5, c h a r a c t e r i s e d i n, that when the MU receive data about a new TPFR through Cell Broadcast then the MU first sends a declaration to the previous TPFR, and communicate simultaneously its change to a new TPFR, and then sends a SMS to the new TPFR with data about the vehicle, the MU identity and network operator, and in which TPFR the MU is registered, and these data are saved in the new TPFR until the vehicle change to a another TPFR.

7. A system according to claim 3-6, characterised in, that the MU will first start to search its GSM-network a certain time after the vehicle has started and if the vehicle parks within this time no SMS is sent to the TPFR.

8. A system according to claim 3-6, characterised in, that the MU is equipped with a push button and a display for the selection and displaying of current tariff or accumulated traffic or parking fee.

9. A system according to claim 3-6, characterised in, that the MU is equipped with an output for controlling the traffic information from a RDS-receiver (Radio Data System) and that this output will be managed trough Cell Broadcast.

10. A system according to claim 3-6, characterised in, that the MU is equipped with an input for connecting a crash sensor whose crash signal will force the MU to send its positioning history file through a SMS to the TPFR.

11. A system according to claim 3-6, characterised in, that the vehicles identity contain data about vehicle registration number why an external search based upon a vehicle registration number in a certain TPFR will show if the vehicle at present time has its MU turned on within a certain location area related to this TPFR.

12. A system according to claim 3-11, characterised in, that systems of type GSM also comprise systems of type DCS 1800 (Digital Cellular System – 1800 MHz) or systems of type PCS 1900 (Personal Communication Services – 1900 MHz).

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 98/00181

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: G07C 1/30, G07B 15/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: G07C, G07B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9601531 A2 (KARBASI, AMIR), 18 January 1996 (18.01.96), figures 1,2, abstract --	1-12
A	WO 9636018 A1 (HIGHWAYMASTER COMMUNICATIONS, INC.), 14 November 1996 (14.11.96), figure 1, abstract --	1-12
A	WO 9525410 A1 (DETEMOBIL DEUTSCHETELEKOM MOBILFUNK GMBH), 21 Sept 1995 (21.09.95), figure 1, abstract --	1-12
A	WO 9630884 A1 (PEDERSEN, WILLY), 3 October 1996 (03.10.96), page 7, line 6 - line 12 --	1-12

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
24 April 1998	19 -05- 1998
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INTERNATIONAL SEARCH REPORT

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PCT/SE 98/00181

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9522131 A1 (NETWORK TECHNOLOGY LTD.), 17 August 1995 (17.08.95), figure 1 --	1-12
A	GB 2295476 A (AZTECH SYSTEMS LTD.), 29 May 1996 (29.05.96), figures 1-4, abstract --	1-12
A	WO 9634366 A1 (TELECOM FINLAND OY), 31 October 1996 (31.10.96), figure 1, abstract --	1-12

INTERNATIONAL SEARCH REPORT

Information on patent family members

02/04/98

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